

III.—Some new Forms of American Rotifera.

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[Plates VII. & VIII.]

THE following presumably undescribed Rotifera were all taken from a shallow clear-water pool in a rocky wood near Trenton, New Jersey, U.S.A.

Mastigocerca mucosa, sp. n. (Pl. VII. fig. 1.)

Lorica in dorsal aspect elongate-elliptical in outline; in side-view obovate, about twice as long as broad (high), ventral surface evenly and slightly convex; dorsum arched, higher anteriorly, and there bearing two anteriorly diverging carinæ more than half as long as the lorica, the walls outwardly inclined, thickest at base, the furrow obliquely curved toward the front, the bottom rounded; anterior margin of lorica truncate, smooth, the posterior aperture ventrally oblique; toe as long as the lorica, slightly decurved; accessory stylets four (or five?), the longest conspicuous, curved, about one fourth as long as the slender, tapering, acute toe, the three (or four?) additional stylets setiform and about one half as long as the principal one; antennæ clavate, apparently not setigerous; lateral antennæ near the posterior extremity, in close proximity to the ventral border, finely and radiately setigerous; brain elongate-saccate, with a large papilliform purplish or black eye on its posterior extremity; alimentary canal large, broad, situated laterad and partly ventrad to the ovary, which, in the writer's specimens, was large, irregular in form, and with numerous developing germs; cesophagus long, conspicuous; contractile vesicle pulsating about twenty-four times per minute; flame-cells ("vibratile tags") large.

Length of lorica $\frac{1}{30}$ inch; foot and toe $\frac{1}{30}$; greatest height of carina $\frac{1}{50}$.

Hab. As mentioned at the head of this paper.

The secretion of the foot-glands is often so copious that it seems to exude from the entire length and substance of the toe, whence it spreads over the glass slide in waves and filaments and fringes, and attaches the animal almost immovably, although it has the ability to withdraw the part for a short distance from its colloid sheath, when the secretion again exudes and again covers the toe as before.

I have not been able to observe even a single seta on the

dorsal antenna. If present they must be exceedingly delicate and minute.

The bottom of the dorsal furrow is elastic, as the animal can draw the lateral wings toward each other.

Tophrocampa clavigera, sp. n. (Pl. VII. fig. 2.)

Exceedingly soft, flexible, and versatile; normally subcylindrical or subfusiform, usually widest near the middle, tapering posteriorly, often producing a postero-central constriction with margins almost straight; dorsum arched, ventrum hollowed; not conspicuously annulose, but the body-margins irregularly crenate or undulate, these projections not rarely becoming obsolete; front rounded and bearing a hook-like projection, visible in side-view much as with *Tophrocampa Saundersii*, Gosse; anterior region frequently retracted; tail represented by a small semicircular lobe dorsal to the soft and flexible subcylindrical foot; toes two, short, stout, conical, and possessing independent movement, being therefore true toes; a small rounded auricle frequently protruded on each side of the head, and so accelerating the animal's movements that it is difficult to observe the form and structure; dorsal cuticular surface conspicuously striate longitudinally or finely fluted, the striæ coarse and more or less parallel with the marginal crenulations; dorsal antenna single, represented by a circumvallation near the frontal border, and probably setigerous, although I have not actually seen the setæ; frontal cilia prone, fine, short, filling an obovate field which occupies from one fourth to one fifth of the anterior ventral surface, and surrounded by numerous subparallel striæ or fine cuticular folds; brain conspicuous, elongate-saccate, from one fourth to one fifth as long as the entire body, and having a small, posterior, central subspherical lobe, which is often coarsely granular, these freely movable granules extending toward the front of the ganglion in a long, narrow, sinuous band, the whole collection then being irregularly subclavate; in some specimens this granular formation is entirely absent or the posterior lobe may alone be granular; eye red, situated on the fore part of the posterior cerebral lobe, which is not rarely apparently adherent to the mastax, the movements of which it then accompanies; intestinal canal continuous, apparently ciliated, widest anteriorly, in lateral aspect suddenly narrowed, and tapering posteriorly, often annulose; cesophagus not observed; a coarsely granular body, presumably the ovary, ventrad to the alimentary canal and extending for almost its

entire length; a small gastric gland is present on each rostral shoulder of the stomach; contractile vesicle in the median line, ventrad to the intestine, oval in contour and conspicuous near the posterior body-margin; lateral canals present, with but four flame-cells visible on each side; two small elongate-ovate foot-glands present; animal's movements constantly writhing and vermicular when unaided by the auricles, but with these appendages rapid, headlong, and seemingly without choice of direction.

Length about $\frac{1}{120}$ inch.

Intestinal canal usually gorged with yellowish-brown food materials.

The species is readily recognizable not only by its form and by the lateral crenulations, but especially by the peculiar granular region of the brain, that particular part being in form not unjustly comparable to a pendulum with a sub-spherical bob, or to a cord with a round weight attached at one end. These granules, which I have not seen in any other portion of the ganglion, are freely movable on one another and in form vary from elongate-ovate to subfusiform. They are probably concretions of lime as so commonly observed in the cerebral ganglia of other Notomatidæ. They are here contained in a tubular case or sheath, and may be motionless by reason of their number. Even when these granules are absent the region which they will at some time occupy is always plainly visible. They seem to be the result of a crystallization within a liquid enclosed by a special membrane within the nerve-mass. The clavate form of the mass suggested the specific name.

Metopidia collaris, sp. n. (Pl. VII. figs. 3 and 4.)

Lorica suboval, depressed, the dorsum rounded, the central region a slightly flattened more or less obovate space, whose margins converge posteriorly into a central ridge extending to the posterior border of the lorica, the lateral regions of the lorica falling away rather rapidly to the convex edge, thus giving the entire dorsum a somewhat tectiform aspect, frequently increased by the presence of a central longitudinal ridge; ventrum flattened; dorsal frontal margin concave, the ventral deeply excavate; the frontal angle on each side prolonged as a conspicuous acuminate process; a narrow, coarsely stippled, collar-like band encircling the entire anterior margin of the lorica; posterior dorsal border narrow, slightly and evenly concave, the ventral margin conspicuously excavate into a deep narrow sulcus, its lateral borders but

slightly divergent, its posterior termination on each side minutely acuminate; dorsal antenna a large deep pit surrounded by a circular or broadly oval ring; lateral antennæ apparently present as small capitate dorso-lateral projections, but upon which I could discover no setæ; foot three-jointed (or four-jointed if the prolongation of the body to which the foot is a continuation be counted as a joint); toes long, tapering; eyes two, red, pectoral, crescentic, placed near the frontal border, in some specimens the appearance of an additional pair of faintly coloured crescentic eye-spots not being rare on the pectoral region; flame-cells small, only one (near the postero-lateral border) having been observed; lateral canals exceedingly numerous, especially in the dorsal region, where they extend beneath the lorica in long loops and in concentric curves, each canal terminating in a trumpet-shaped mouth apparently not ciliated, and without an undulating membrane, the vessels together imperfectly separable into three groups, one central, two lateral; contractile vesicle large, ventrally and transversely placed near the anterior extremity of the ventral sulcus and variously compressed and changed in form by the pressure of the viscera.

Length about $\frac{1}{30}$ inch; length of lorica $\frac{1}{14}$; toes and foot $\frac{1}{33}$.

The figure (made with a camera lucida) was drawn from a specimen under slight pressure, and the head is therefore too much rounded and too prominent.

The frontal plate is movable and flexible. When the body is contracted this plate is folded over the rounded part and serves as a protection to the otherwise defenceless region.

This seems to be the only known species with a stippled band around the front border. This feature, together with the lateral spinous processes, and especially with the numerous canals of the vascular system, with their curves and their trumpet-shaped mouths, makes the form one easily recognizable. The Rotiferon frequently, I think usually, swims on the back, thus concealing some important and interesting structural features.

Metopidia collaris, var. *similis*, nov.

(Pl. VII. fig. 5.)

The foregoing species is so frequently accompanied or even replaced by one or more varieties so distinct from it in the form and the size of the lorica, that it merits varietal recognition and a varietal name, as I have given it.

The lorica is evenly oval in outline, depressed, the ventrum

slightly concave, the dorsum arched, conspicuously or not, tectiform when the central, longitudinal, ridge-like elevation is present, as it may or may not be; two low, lateral, posteriorly converging ridges conspicuously or obscurely developed or entirely absent, but when present the enclosed more or less obovate dorsal space surrounded by them is flattened; frontal dorsal margin evenly but deeply concave; ventral border excised much as in *Metopidia collaris*; frontal angles acuminate, not produced into spinous processes; dorsal posterior border very slightly concave; posterior ventral margin deeply excised, the lateral borders of the excision diverging or parallel; collar-like frontal band usually present, sometimes coarsely and abundantly punctate, sometimes entirely smooth; foot and toes essentially as in *Metopidia collaris*; internal organization not apparently differing from that of the type.

Length about $\frac{1}{160}$ inch; length of lorica alone $\frac{1}{300}$; toes $\frac{1}{1000}$; foot and toes $\frac{1}{400}$.

This differs from the type in the deeper concavity of the front of the dorsum, in the reduction of the lateral spines to mere acuminations, in the absence of the slight posterior acumination terminating the posterior ventral excision, and in the smaller size, although the size alone is of little importance.

Internally there appear to be no prominent differences, except that I have not positively observed the peculiar arrangement of the lateral canals within the dorsum which seems so characteristic of *M. collaris*; but these often are obscure in that species when the ovarian germs are well advanced or when the egg is well developed, or sometimes even when the alimentary canal is gorged with food or with its remains.

Monostyla hamata, sp. n.
(Pl. VII. figs. 6, 7, and 8.)

Lorica broadly ovate in outline; front differing in form on both the dorsal and the ventral surfaces, as shown by figs. 6 and 7 better than any verbal description could do. The figures were drawn with the camera lucida, and represent the lorica frontally dilated as it is when the enclosed body is retracted; when the animal is extended the elastic front is narrower than here shown, and the two acuminations on each side of the dorsal excavation become less conspicuous; foot and toe together about one half as long as the lorica; toe not shouldered.

When the body is extended it bears on its front dorsal margin three sub-semicircular membranous lobes (fig. 8), the

lateral two extending to the ventral surface, their outer borders apparently thickened into a small chitinous hook, the inner surfaces of these membranes coming into contact when the body is retracted, then frequently forming a nipple-like projection; brain large; œsophagus lined by long, conspicuous, flagella-like cilia, which are pendent into the stomach.

Length, including toe, $\frac{1}{100}$ inch.

Monostyla robusta, sp. n. (Pl. VII. figs. 9 and 10.)

Lorica subcircular in outline, but little longer than broad; ventral surface flattened, dorsal arched, steeply sloping anteriorly when the animal is contracted, the frontal region of the lorica being flexible; frontal borders concave, undulate, the ventral with a broad central emargination; each lateral frontal angle terminated by a short incurved acumination; toe rod-like, straight, terminating in two short acuminate claws, distinctly parted, especially at their extremities, and projecting from between two small setiform spines; entire lorica coarsely punctate, lateral antennæ small, projecting on each side within the lateral sulcus, near the posterior extremity and from the upper surface of the lower or ventral region of the groove; dorsal antenna a single setigerous circumvallation; brain conspicuous, large; eye single, large, circular, red, granular, and superficially placed near the middle of the nerve-ganglion; the stomach bears internally, near the entrance of the œsophagus, a ligulate undulating membrane (or tube?), coarsely striate longitudinally, and about $\frac{1}{100}$ inch long.

Length of lorica, including toes and claws, $\frac{1}{38}$ inch; length of lorica alone $\frac{1}{50}$ inch; width $\frac{1}{21}$. Toes and claws together about one half as long as the lorica.

The claws are distinctly, even conspicuously, two, being visibly parted throughout their entire length, and actually separated at their tips; they are immovable, or appear to be so.

The general form, the frontal acuminations, the parted claws between the setiform spines make the species one that is easily recognizable, and not likely to be mistaken for any other thus far observed.

No varieties of the species have yet been found, although one or more may probably exist. I have, however, observed a specimen with the toe and claws as shown in fig. 10, where there was but one setiform spine, stouter and more conspicuous than usual, and where the toe was undulate and peculiarly malformed.

Monostyla bipes, sp. n.
(Pl. VIII. figs. 11, 12, and 13.)

Lorica broadly oval, the dorsal surface strongly gibbous, the ventral only slightly rounded, nearly plane (fig. 11); a posterior retrocession obliquely and convexly truncate, and overhanging a broad somewhat oblique extension; frontal border deeply emarginate, the ventral emargination nearly twice as deep as the dorsal, both incisions posteriorly rounded (figs. 12 and 13); entire surface of lorica stippled; toe about three fourths as long as the entire lorica, somewhat decurved and tapering in lateral view; in ventral aspect minutely emarginate near the middle, beyond which it is slightly constricted, and has on each side a fine setiform spine, from between which extends the tapering claw, which is in reality double, having at or near the level of the setiform spines a small brightly refractive spot, which represents an aperture and from which passes posteriorly a distinct dark line dividing the claw into two, these portions never being widely parted, but readily resolvable into two.

The internal anatomy, with the exception of the œsophagus, presents nothing of unusual structure. The œsophagus, however, encloses a structure readily observable when in action, but difficult to interpret. The optical appearance is that of an endless series of internal rings gliding along the œsophagus toward the stomach. There is no visible return of the travelling circles, but the procession is endless and continuous. That the appearance is produced by the undulations of a spiral membrane, as in the flame-cells of so many of the Rotifera, is hardly probable; that, in addition to the ordinary lining of minute cilia, the œsophagus bears a series of large flagelliform cilia arranged spirally on the inner wall, or that true flagella may thus be arranged there, are suggestions more easily made than proved. But the fact remains that the downwardly gliding ring-like bodies, whatever their true character may be, are conspicuous features within the œsophagus of the species, and are probably flagella or a single long flagellum spirally encircling the tube.

Length, including foot, $\frac{1}{115}$ inch.

At the death of the animal I have distinctly seen the two claws slightly parted, so that there was a clear space between them, and the terminal point, usually single in appearance, became plainly double. It is to emphasize this part of the anatomy that I have given this species a name which, with the generic title, makes a rather unusual collocation.

Salpina similis, sp. n.
(Pl. VIII. figs. 14, 15, 16, 17, and 18.)

Lorica much as in *Salpina brevispina*, Ehr. Occipital spines entirely wanting; the pectoral pair short, acute, wide at base and strongly curved upward (fig. 14); posterior spines long and conspicuous, the alvine pair nearly twice as long as the lumbar one, with a slight upward curve, the lumbar being at the termination of the dorsal cleft and slightly recurved; entire surface finely stippled, a broad coarsely punctate band or collar surrounding the frontal region (fig. 14); dorsal cleft (fig. 16) narrow, elastic, with a deep depression at its frontal termination, its lateral borders sloping outward from a straight base; lateral antennæ present near the posterior border (figs. 15 and 16), the nerve-fibre prominent, at first filiform, whence it conspicuously widens to become again thread-like; frontal antenna lobe-like; brain large, its latero-ventral region appearing to bear several fusiform lobes; mastax globose; œsophagus long, variously curved, and lined by long, conspicuous, flagella-like cilia, which are pendent within the stomach and plainly distinct from its lining of short fine cilia; a gastric gland attached on each side to the antero-inferior region of the stomach; ovary ventrad, extending transversely to the stomach and the intestine; contractile vesicle nearly one half as long as the lorica, and, when fully dilated, crowding the ovary forward against the gastric glands; two small, broadly ovate, ventral glands, one on each side near the posterior extremity, apparently foot-glands.

Length, including toes, $\frac{7}{5}$ inch.

The points of difference between this species and the *Salpina brevispina* of Ehrenberg are the long posterior spines, the acute, curved pectoral spines, the deep, broad, more or less rectangular, dorso-frontal emargination, and the long œsophageal flagella, which are so obtrusive that they could not be overlooked if they were present in *S. brevispina*. *S. similis* is twice as large as *S. brevispina*.

In a single instance, and entirely by accident, while subjecting the Rotiferon to pressure, living spermatozoa were forced from the cloacal orifice into the surrounding water, where they soon died. When viewed with insufficient magnifying power each spermatozoon seemed to be a minute sphere with a single long flagellum; but this is by no means certain. The seminal receptacle was not seen.

A somewhat smaller variety of this species occurs in the same pool. It differs from the foregoing in having the pectoral spines straight (fig. 18), the alvine and the lumbar

nearly straight, the alvine being somewhat the shorter (fig. 17), and all shorter than those of *S. similis*. The sinus between the posterior spines (fig. 17) shows a rather conspicuous bulging, while in *Salpina similis* the sulcus is entirely even and evenly rounded. The front is likewise more evenly rounded (fig. 18), with a more decided bulging at or near the buccal orifice. Internally the only apparent differences are the smaller contractile vesicle of the variety and the strong internal ciliation of the œsophagus, instead of the conspicuous flagella as with *S. similis*, the œsophageal cilia of the variety scarcely differing from those of the stomach, and not extending into that organ as an undulating fascicle. The granulations of the anterior lorical collar are coarser and fewer than those of the same part on *Salpina similis*. These points of difference are hardly sufficient to warrant the describing of these specimens as a new species.

Rattulus palpitatus, sp. n. (Pl. VIII. fig. 19.)

Lorica subcylindrical, widest anteriorly, somewhat tapering posteriorly, both extremities truncate, but in opposite directions; toes curved, continuing the general curvature of the lorica, tapering, acute, about one fourth as long as the body; basal stylet apparently none; dorsal contour of the lorica in lateral view closely approximating the segment of a circle; brain not opaque, large, broadly ovate, bearing at its posterior extremity a large red papilliform eye-spot; mastax large, the trophi unequal; gastric glands dorsad to the frontal region of the stomach and apparently united into one; ovary large, ventrad to the ciliated stomach and to the intestine; contractile vesicle small, near the posterior extremity of the lorica, in the median line, and pulsating at the rate of about forty contractions per minute, the cloaca being forced open for a short distance at each pulsation.

Length of the extended body, exclusive of the toes, about $\frac{1}{270}$ inch; greatest lateral width (height) near the middle of the lorica and about $\frac{1}{800}$ inch.

The species is remarkable on account of the rapidity with which the contractile vesicle pulsates, the number averaging about forty each minute when the animal's movements are but slightly restricted and when it seems to be well and at ease; when it is held by the pressure of the cover-glass the pulsations become irregular.

The toes I have not seen separated.

It is not easy to retain the curved and rigid body so that either a direct dorsal or ventral view may be obtained, but

from the few glimpses which I have had of the dorsal aspect the gastric gland seems to be single, narrow, and to extend obliquely across the frontal region of the stomach; but of this there is no certainty, as momentary glances were all that I could obtain, the body always slipping over to its side. The animal's unrestrained movements are rotatory on its longitudinal axis.

Notommata mirabilis, sp. n. (Pl. VIII. figs. 20 and 21.)

Body very soft and versatile; in dorsal view broadly ovate, posteriorly prolonged into a foot-like portion; dorsum rounded; ventrum flattened; front evenly and broadly convex, and entirely without cilia, which are confined to an anterior obovate space on the ventral surface; auricles small, sub-hemispherical, rarely protruded; lateral borders of the body projecting on each side beyond the elevated and rounded dorsal region as a flattened cuticular extension; posterior region narrowed and prolonged ventrally into two broad conical toes, and dorsally into a narrow irregularly cylindrical tail, which is shorter and smaller than the toes and habitually held almost perpendicularly, so that when the animal is seen in dorsal aspect this appendage appears in optical section like a small ring or an elongated papilla, but in lateral view is seen to be attached to the body by a minute peduncle, above which it is subglobosely inflated, tapering thence with convex borders to the subacute apex; sense-organs (antennæ or tentacles) four in number—one a small densely setigerous pimple on each side of the convex front, and one a rather more conspicuous seta-bearing papilla on each lateral border of the dorsum, somewhat posterior to the transverse median line; brain large, not lobed, translucent, with one or more posterior collections of opaque granules and with a dark, almost black, posterior eye-spot; contractile vesicle posterior, in the median line, large, and, when fully expanded, about one third as long as the body.

Length from $\frac{1}{150}$ to $\frac{1}{167}$ inch.

The somewhat tripod combination of foot and tail bears considerable resemblance to those parts in *Notommata tripus*, Ehr., and in *Notommata pilarius*, Gosse; but the species is readily separated from both not only by the less robust character of the tail, by its form and its perpendicular position, but by the exceedingly peculiar and characteristic, not to say unique, sense-organs, which at once distinguish it from all known forms of the genus, and place it within not distant

relationship to *Copeus*, from which it is separated by the smaller size, the more active movements, and especially by the entire non-lobate brain.

The stomach bears an internal undulating organ similar in general appearance and in movement to the membranous appendage within the stomach of *Monostyla robusta* and of certain other Rotifera. The animal has entire control over the movements of this appendage, hastening or retarding them, or throwing the membrane into various convolutions and irregular vibrations.

The wing-like extensions of the body apparently carry none of the internal anatomy except the lateral canals, which are almost entirely contained within a narrow elongate mass of granular tissue, where there seems to be but one flame-cell, and that usually indistinct. Other vibratile cells probably exist, but they are not ordinarily visible. With many specimens of the Rotiferon, which is not rare in my locality in New Jersey, I have not been able to discover any other arrangement than this of the vascular system.

The tail is usually as shown in the figure (fig. 21), but occasionally the bulbous portion is less distinct, while the entire appendage seems to be somewhat elastic and changeable.

EXPLANATION OF THE PLATES.

PLATE VII.

- Fig. 1. *Mastigocerca mucosa*.
 Fig. 2. *Taphrocampa clavigera*.
 Fig. 3. *Metopidia collaris*. Ventral view.
 Fig. 4. Ditto. Front of dorsum.
 Fig. 5. *Metopidia collaris*, var. *similis*. Lorica.
 Fig. 6. *Monostyla hamata*. Dorsal view.
 Fig. 7. Ditto. Ventral view.
 Fig. 8. Ditto. Expanded front.
 Fig. 9. *Monostyla robusta*.
 Fig. 10. Ditto. Malformed toe.

PLATE VIII.

- Fig. 11. *Monostyla bipes*. Lateral view.
 Fig. 12. Ditto. Dorsal view.
 Fig. 13. Ditto. Ventral front.
 Fig. 14. *Salpina similis*. Front of lorica.
 Fig. 15. Ditto. Side view of animal.
 Fig. 16. Ditto. Dorsal view of animal.
 Fig. 17. Ditto. Posterior extremity of small variety.
 Fig. 18. Ditto. Lorica front of small variety.
 Fig. 19. *Rattulus palpitatus*. Lateral view.
 Fig. 20. *Notommata mirabilis*.
 Fig. 21. Ditto. Tail.